

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re PATENT APPLICATION OF

Inventor(s): ITO et al.

Filed: Herewith

Title: GROUP III NITRIDE COMPOUND SEMICONDUCTOR DEVICE

December 18, 2001

**PRELIMINARY AMENDMENT**

Hon. Commissioner of Patents  
Washington, D.C. 20231

Sir:

Please amend this application as follows:

**IN THE SPECIFICATION:**

At the top of the first page, just under the title, insert:

This is a Divisional of U.S. Application No. 09/518,724, filed March 3, 2000,  
the entire contents of which are incorporated by reference.

Please amend the specification as follows:

Page 1, delete the whole paragraph starting with line 5 and replace it with the  
following new paragraph.

This invention relates to a group III nitride compound semiconductor device. More  
particularly, it relates to an improvement in an undercoat layer for a group III nitride  
compound semiconductor layer such as a GaN semiconductor layer.

Page 1, delete the whole paragraph starting with line 22 and replace it with the following new paragraph.

A substrate for a semiconductor device needs certain characteristics such as stiffness, impact resistance, etc. for keeping to maintain the function of the device. It is thought that the substrate needs a thickness of 100  $\mu\text{m}$  or larger in order to keep the characteristic when the substrate is formed of metal nitride.

Page 2, delete the whole paragraph starting with line 12 and replace it with the following new paragraph.

One of the problems to be solved in the sapphire substrate is as follows. That is, the sapphire substrate is transparent, so that light of the light-emitting device to be originally taken out from an upper face of the device passes through the sapphire substrate. Hence, light emitted from the light-emitting device cannot be used effectively.

Please delete the paragraph bridging pages 2 and 3 and replace it with the following new paragraph.

On the other hand, substituting an Si (silicon) substrate for the sapphire substrate may be thought of. According to the inventors' examination, it was, however, very difficult to grow a GaN semiconductor layer on the Si substrate. One cause of the difficulty is the difference in thermal expansibility between Si and the GaN semiconductor. The linear expansion coefficient of Si is  $4.7 \times 10^{-6}/\text{K}$  whereas the linear expansion coefficient of GaN is  $5.59 \times 10^{-6}/\text{K}$ . The former is smaller than the latter. Accordingly, if heating is performed when the GaN semiconductor layer is grown, the device is deformed so that the Si substrate is expanded while the GaN semiconductor layer side is contracted relatively. On this

**ITO et al.**

occasion, tensile stress is generated in the GaN semiconductor layer, so that there is a risk of occurrence of cracking as a result. Even in the case where cracking does not occur, distortion occurs in the lattice. Hence, the GaN semiconductor device cannot fulfill its original function.

**IN THE CLAIMS:**

Please cancel claims 7, 12-19, 21 and 22 without prejudice or disclaimer.

30247311\_1.DOC

REMARKS

By this amendment, claims 7, 12-19, 21 and 22 have been cancelled without prejudice or disclaimer of the subject matter recited therein. Claims 1-6, 8-11 and 20 are pending.

It is respectfully submitted that the present application is in condition for allowance and a Notice to that effect is earnestly solicited. If the Examiner believes any issues remain unresolved, the Examiner is encouraged to contact the undersigned by telephone to expedite the prosecution of this application.

Respectfully submitted,

PILLSBURY WINTHROP LLP

By: John P. Darling

Attorney: John P. Darling  
Reg. No: 44,482  
Tel. No.: 703/905-2045  
Fax No.: 703/905-2500

JPD/VPH:ksh  
1600 Tysons Boulevard  
McLean, VA 22102  
(703) 905-2000

Attachment: Appendix

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Please amend the specification as follows:

Change the paragraph beginning on page 1, line 5 as follows:

This invention relates to a group III nitride compound semiconductor device. More particularly, it relates to an improvement in an undercoat layer for a group III nitride compound semiconductor layer such as a GaN semiconductor layer.

Change the paragraph beginning on page 1, line 22 as follows:

A substrate for a semiconductor device needs certain [characteristic] characteristics such as [( ]stiffness, impact resistance, etc.[ ) for keeping] to maintain the function of the device. It is thought [of] that the substrate needs a thickness of 100  $\mu\text{m}$  or larger in order to keep the characteristic when the substrate is formed of metal nitride.

Change the paragraph beginning on page 2, line 12 as follows:

One of the problems to be solved in the sapphire substrate is as follows. That is, the sapphire substrate is transparent, so that light of the light-emitting device to be originally taken out from an upper face of the device passes through the sapphire substrate. Hence, light emitted from the light-emitting device cannot be used effectively.

Change the paragraph bridging on pages 2 and 3 as follows:

On the other hand, substituting an Si (silicon) substrate for the sapphire substrate may be thought of. According to the inventors' examination, it was, however, very difficult to grow a GaN semiconductor layer on the Si substrate. One [of causes] cause of the difficulty is the difference in thermal expansibility between Si and the GaN semiconductor. The linear expansion coefficient of Si is  $4.7 \times 10^{-6}/K$  whereas the linear expansion coefficient of GaN is  $5.59 \times 10^{-6}/K$ . The former is smaller than the latter. Accordingly, if heating is performed when the GaN semiconductor layer is grown, the device is deformed so that the Si substrate is expanded while the GaN semiconductor layer side is contracted relatively. On this occasion, tensile stress is generated in the GaN semiconductor layer, so that there is a risk of occurrence of cracking as a result. Even in the case where cracking does not occur, distortion occurs in the lattice. Hence, the GaN semiconductor device cannot fulfill its original function.

END APPENDIX